REMARKS/ARGUMENTS

This case has been carefully reviewed and analyzed in view of the Official Action dated 30 November 2005. Responsive to the rejections made in the Official Action, Claims 1 and 19 have been amended to clarify the combination of elements which form the invention of the subject Patent Application and Claims 2-6, 13, 17, 18, and 20 have been amended to provide proper antecedent basis for the limitations thereof in light of the amendments made to independent Claim 1 and 19.

In the Official Action, the Examiner rejected Claims 1-11, 19-21 and 24-26 under 35 U.S.C. § 102(a), as being anticipated by Schleier-Smith, U.S. Patent 6,669,918. The Examiner stated that the reference discloses a method for bulk separating single-walled fullerenes based on chirality which includes the step of forming a template on a crystalline substrate having a plurality of openings. The Examiner further states that the reference discloses the next step of exposing the template to a suspension of single-walled fullerenes of random chiralities for adsorption of fullerenes having a selected chirality, and then removing the adsorbed fullerenes. The Examiner further states that the limitation of flowing the fullerenes on a substrate at a predetermined angle is inherently possessed by the reference because whatever angle the fullerenes flow over the substrate is the "predetermined angle".

Before discussing the distinguishing features of the invention of the subject Patent Application over that of the reference relied upon by the Examiner, it is believed beneficial to first briefly review the method and structure of the invention of the subject Patent Application as now claimed. The invention of the subject Patent Application is directed to a method for bulk separation of single-walled tubular fullerenes based on helicity. The method includes the steps of providing a plurality of single-walled fullerenes, and providing a substrate having a lattice structure. The method further includes the step of directing a flow of the plurality of single-walled tubular fullerenes on the substrate at an angle with respect to an axis of the lattice structure of the substrate selected to attract and hold single-walled tubular fullerenes of a predetermined helicity to the substrate. Still further, the method includes the step of removing the single-walled tubular fullerenes held to the substrate.

From another aspect, as defined in Claim 19, the invention of the subject Patent Application is directed to a system for bulk separation of single-walled tubular fullerenes based on helicity. The system includes a container of a fluid bearing single-walled tubular fullerenes. The single-walled tubular fullerenes each have a longitudinal axis. The system also includes a dispensing assembly having at least one outlet for discharging the single-walled tubular fullerenes in a directed flow and at least one inlet coupled in fluid communication with the container and spaced from the outlet. The system includes a substrate having a lattice structure,

the lattice structure of the substrate having a selected axis disposed in an angular relationship with respect to the directed flow from the at least one outlet of the dispensing assembly. The axis is at an angle selected to attract and hold single-walled tubular fullerenes of a pre-determined helicity to the substrate as the single-walled tubular fullerenes flow thereover. Still further, the system includes a drainage assembly disposed adjacent to the substrate for carrying off any of the fluid bearing single-walled tubular fullerenes not held on the substrate. By that method and system, a template formed on the surface crystalline lattice of the substrate is not required to effect chirality based bulk separation of single-walled tubular fullerenes.

In contradistinction, the Schleier-Smith reference is directed to a method for bulk separation of single-walled tubular fullerenes based on chirality which does rely on a template 40 to achieve the selective separation of the tubular fullerenes. As clearly shown in Fig. 3b, the substrate 30 of the template 40 is only exposed in the narrow elongated openings 32. The openings 32 extend at an angle with respect to the substrate lattice axis which is the "locking angle" for the tubular fullerenes of a selected chirality. Thus, when the template is exposed to a suspension of fullerenes having random chiralities, the tubular fullerenes of the selected chirality will be adsorbed at the elongated opening sites 32, while tubular fullerenes of other chiralities are not adsorbed to the template. If the template is simply submerged in the suspension of fullerenes, whatever "flow" occurs will be

random, and therefore does not provide for directing a flow of the plurality of single-walled tubular fullerenes on the substrate at an angle with respect to an axis of the lattice structure of the substrate selected to attract and hold single-walled tubular fullerenes of a predetermined helicity to the substrate, as now claimed. Further, where an electrodeposition process (column 4, lines 48-61) is utilized, the "directed flow" is orthogonal to the plane of the substrate and therefore neither discloses nor suggests a directed flow at an angle with respect to an axis of the lattice structure of the substrate selected to attract and hold single-walled tubular fullerenes of a predetermined helicity to the substrate, as now claimed.

The Schleier-Smith reference neither discloses, nor inherently possesses, nor suggests that one could separate single-walled tubular fullerenes based on chirality by directing a flow of the fullerenes over the template at any particular angle. At the time of the Schleier-Smith invention, it was not known in the art, nor to the Inventors, the dramatic increase in magnitude of the attractive force between the tubular fullerenes and the lattice of the substrate at the "locking angle". That lack of knowledge is evidenced by the use of the electrodeposition process, using electro-dynamic forces to "propel" the tubular fullerenes into contact with the substrate. It was not until the Inventors of the subject Patent Application proceeded to perform the very difficult analysis and calculations necessary to determine the interactive energy between the nanotubes and the substrate lattice, the results of which are shown in Fig. 4, that use of directed flow

was even contemplated as a possible means of achieving separation of nanotubes based on chirality. The results of that analysis and the calculations was subsequently published in Physical Review Letters, Vol. 92, 085503, 27 February 2004. Therefore, the Schleier-Smith reference cannot anticipate or make obvious the invention of the subject Patent Application.

With respect to Claims 4-11, the reference neither discloses, nor suggests nor inherently produces a directed flow which includes the step of aligning longitudinal axis of the plurality of single-walled tubular fullerenes with a direction of flow thereof, as claimed. As previously discussed, the only directed flow method disclosed by the reference is that of electrodeposition wherein the tubular fullerenes are driven toward the surface of the substrate in a direction that is orthogonal to the plane of the substrate. Arguendo, even if the "fluid dynamics" of that method caused the tubular fullerenes to be oriented along the axis of the "flow" such would be detrimental to the deposition process, as the fullerenes would be orthogonal to the axis of the openings 32 exposing portions of the substrate. It is respectfully submitted that even flow through a "pipe" would not produce fluid dynamics which would guarantee alignment of the nanotubes in the direction of the flow. Alignment of nanotubes in a flow is known in the art to be difficult, as there are strong interactions between the nanotubes themselves that cause them to agglomerate. It is for that reason that the invention of the subject Patent Application utilizes one of the specific techniques for forcing the nanotubes

to align, the techniques being confinement-based alignment, sheer-based alignment, extensional flow alignment, liquid crystal alignment, and directional electric susceptibility.

Most importantly, by directing the tubular fullerenes in a flow the invention of the subject Patent Application is able to lift the requirement for the template required in the Schleier-Smith reference and thereby, provide a more efficient continuous process for bulk separation of nanotubes. The Schleier-Smith reference, by contrast, is directed to a discontinuous, stepwise, repetitive process. Further, a different template must be fabricated for each chirality to be separated from a source of random chiralities. Still further, the required template restrict the total area of the substrate exposed to the tubular fullerenes. Although the reference provides a novel scheme for bulk separation of nanotubes that was heretofore not possible, the invention of the subject Patent Application is able to separate a greater number of nanotubes at any one time by increasing exposed substrate surface area available for adsorption of nanotubes. The continuous nature of the process provides for a further increase in the rate at which the nanotubes can be separated, and greater efficiency is also achieved in the elimination of the requirement for multiple templates for different chiralities. In the invention of the subject Patent Application, the angle of the directed flow with respect to the substrate lattice is simply changed from the locking angle for

nanotubes of one chirality to the different locking angle required to separate nanotubes of another chirality.

Hence, the method of the reference and that of the invention of the subject Patent Application are different processes requiring different components that are not inherently provided by the practice of the Schleier-Smith invention. A directed flow of tubular fullerenes as claimed in the subject Patent Application is not required to practice the referenced method, nor contemplated by that reference. It is clear that any flow established by the method of the Schleier-Smith reference is either random, or orthogonal to the plane of the substrate. Nowhere does the reference disclose, suggest or inherently provide a dispensing assembly having at least one outlet for discharging the single-walled tubular fullerenes in a directed flow and at least one inlet coupled in fluid communication with the container and spaced from the outlet, as now claimed. Nor does the reference, disclose, suggest or inherently provide a substrate having a lattice structure, the lattice structure of the substrate having a selected axis disposed in an angular relationship with respect to the directed flow from the at least one outlet of the dispensing assembly, the axis being at an angle selected to attract and hold single-walled tubular fullerenes of a pre-determined helicity to the substrate as the single-walled tubular fullerenes flow thereover, as now claimed. As the reference fails to disclose or suggest a directed flow, it likewise neither discloses, suggests nor inherently provides a drainage assembly disposed adjacent to the substrate for carrying off

any of the fluid bearing single-walled tubular fullerenes not held on the substrate, as claimed. For the same rationale as set forth above, the reference fails to disclose, suggest or inherently provide any of the components defined in Claims 21 and 24-26.

Therefore, as the reference fails to disclose each and every one of the method steps and elements which respectively form the method and structure of the invention of the subject Patent Application, it cannot anticipate that invention. Further, as the reference fails to suggest such a combination of method steps and elements, and in fact teaches away from the method and structure of the invention of the subject Patent Application by its very use of a template, it cannot make obvious that invention either, as now claimed.

In the Official Action, the Examiner rejected Claims 1-11, 13-16, 19-22 and 24-26 under 35 U.S.C. § 103(a), as being unpatentable over Schleier-Smith. The Examiner reiterated a prior rationale and additionally stated that the method steps of Claims 4-6 or obvious expedience, "to obtain better fluid flow" and stated that the subject matter of Claims of 7-11, 14 and 15 were either inherent or would have been obvious to use any structure that would work.

The arguments previously made with respect to the lack of inherency and non-obviousness of the invention of the subject Patent Application with respect to the Schleier-Smith reference are reiterated with respect to the '103 rejection. However, the undersigned Attorney would like to respond to particular issues

raised by the Examiner and emphasize the fact that nowhere does the reference disclose or suggest a method or structure wherein there is a directed flow of the plurality of single-walled tubular fullerenes on the substrate at an angle with respect to an axis of the lattice structure of the substrate selected to attract and hold single-walled tubular fullerenes of a pre-determined helicity to the substrate, as now claimed. As there is no disclosure or suggestion of a directed flow in the reference, there would be no motivation for alignment of the longitudinal axis of the tubular fullerenes in an axis of any flow of the suspension of tubular fullerenes in the method and system of Schleier-Smith, whether inadvertently or intentionally produced by that method or system thereof. Therefore, it could only be through the impermissible use of "hindsight" that the Examiner even suggests that one skilled in the art would align the longitudinal axis of the fullerenes in the direction of a flow, using Applicant's own disclosure as a "blueprint" for that suggestion.

The invention of Schleier-Smith requires the exposure of a template to a suspension of tubular fullerenes, and in no way discloses, suggests or inherently provides flow though any type of pipe. Even if it did, since the referenced method does not require a flow across the substrate at any particular angle, one skilled in the art would be more likely to simply increase the diameter of the pipe to increase flow and avoid fullerenes from being stuck inside the outlet passage, rather than attempt to orient the fullerenes to be aligned with the direction of flow, which is not easily accomplished. As previously stated, in order to achieve longitudinal

alignment of the fullerenes in the flow, particular techniques must be utilized, as the elementary "fluid dynamics" of a flow of nonotubes alone will not achieve the longitudinal alignment of the axis of the nanotubes with flow. The techniques for aligning the nanotubes require the dimensions and/or contour of the pipe and/or the flow rate, or the composition of the fluid, or particular pretreatment of the fullerenes to be provided in order to achieve the alignment, and thus are not inherent in simply providing a pipe for the suspension to flow through (which is not required or suggested by the reference) or obvious to achieve an operable system employing the referenced method.

With respect to the size of the outlet passage (Claim 8), the claimed limitation is not directed to an optimization of the size of the outlet passage to achieve such characteristics as maximum flow, minimum back pressure or the like. The limitation corresponding to the size of the outlet passage in Claim 8 is related to the confinement-based method of achieving longitudinal alignment of the nanotubes, which is not made obvious by the reference. It is respectfully submitted that the citation (In re Boesch) is directed to a case wherein the claimed limitation was an optimization of a range of a variable, wherein the prior art overlapped that range. In that case, the Court held that "the prior art would have suggested the kind of experimentation necessary to achieve the claimed composition, including the proportional balancing [of the variable]". The fact that the prior art "suggested the optimization of the range," provided a prima fascia

case for obviousness, which then could be rebutted, in re Boesch, 205 U.S.P.Q. 215, 219 (CCPA 1980). Those conditions are not present in this case. Without the suggestion in the prior art to do the optimization of an outlet passage or in anyway provide a passage dimensioned to cause the nanotubes to become aligned with the flow, there is no prima fascia basis for a '103 rejection of the Claim.

With respect to Claims 12 and 13, the Examiner refers to the Schleier-Smith disclosure of functionalization to improve the solubility of the tubular fullerenes, column 5, lines 12-24. Clearly, such functionalization for improving solubility has nothing to do with creating each tubular fullerene into a dipole so that its orientation can be adjusted utilizing electric or magnetic fields. As disclosed in both Schleier-Smith and the subject Patent Application, it is well known in the art to functionalize nanotubes to achieve a particular result. In the invention of the subject Patent Application, functionalization may be utilized to improve susceptibility to an electric or magnetic field in order to influence the orientation of the nanotube in the flow, which is neither disclosed nor suggested by the reference. The fact that functionalizing carbon nanotubes is known in the art, without more, is not a sufficient basis for making obvious functionalizing the plurality of single-walled tubular fullerenes with molecular groups having one of a high electric or magnetic susceptibility, as claimed. In fact, the Examiner admits the reference discloses functionalization with amines which "do not have high electric or magnetic susceptibility," but relies on the use of an electrodeposition

process for motivation to otherwise functionalize the nanotubes. It is resptfully submitted that the displacement of nanotubes between a cathode and anode is far different than causing the nanotubes to be oriented in a particular direction, and is not suggested by the reference.

With respect to Claims 19-21 and 24-26, the prior arguments are reiterated with respect to the rejection of these Claims. The method of Schleier-Smith is very much different from that of the invention of the subject Patent Application and in no way utilizes or suggests positioning a substrate in an angular relationship with respect to the directed flow from the at least one outlet of the dispensing assembly, the axis of the substrate lattice being at an angle selected to attract and hold single-walled tubular fullerenes of a predetermined helicity to the substrate as the single-walled tubular fullerenes flow thereover, as now claimed. Thus, there is no motivation provided by the reference for any of the claimed structure and again, it could only be by the improper use "hindsight" that the Examiner suggests such as being obvious in light of the disclosure of the cited reference. Hence, the Schleier-Smith reference cannot make obvious the invention of the subject Patent Application, as now claimed.

MR1735-89
Serial Number: 10/669,337
Reply to Office Action dated 30 November 2005

It is now believed that the subject Patent Application has been placed in condition for allowance, and such action is respectfully requested.

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Dated: 28 April 2006

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DAVID I. KLEIN 4/28/2006
Date